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RESEARCH REPORT NO. 4

ALKALINE SULPHITE PULPING OF E. TERETICORNIS

Based on the work

of

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NOTE

The findings given in the report are those considered appropriate at the time of its preparation when only laboratory results were available. The final findings are to be confirmed on pilot plant scale. All the units used in this report are SI units. Conversion factors for old units are given in Annexure 1.

ACKNOWLEDGEMENTS

This work is carried out in the Institute's research laboratories located in the premises of Cellulose and Paper Branch of the Forest Research Institute, Dehra Dun.

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ABSTRACT

Experiments were carried out in laboratory to prepare alkaline sulphite pulps from Eucalyptus tereticornis with a view of utilising these pulps as newsprint furnish. The details of impregnation and refining conditions were presented. The strength properties of final pulps were determined and the results were discussed. Bleaching with hypochlorite as well as Hydrogen peroxide was carried out separately. The optical properties were determined for the hand sheets. The results indicate that using Sodium hydroxide in combination with sodium sulphite gives pulps of reasonable strength properties.

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1. INTRODUCTION

There are a number of publications dealing with laboratory research on chemimechanical pulps from hardwoods. The morphology of hardwood fibres is entirely different from that of softwood and consequently their behaviour in refining is also different.

Softwoods produce about 27% of fines which partly originate from the primary wall of the fibre. These fines are highly fibrillated. These fines contribute to the consolidation of the paper and formation of interfibre bonds. Hardwoods on the contrary produce fines which consist mainly of broken ray cells and middle lamella debris. This fine fraction is little fibrillated and is not useful. This is even detrimental to the strength of paper. These differences have been demonstrated by Giertz (1) who had pointed out that the low strength of most hardwood mechanical pulps depend upon the character of the fine material and not on the quality of the fibre fraction. Deb (2) has shown that hardwoods can be made to behave like softwoods under refining by a suitable chemical treatment of chips. The wood can be softened in such a way that primary wall and S1 layer are peeled off producing fibrillar fines and leaving an intact S2 layer. The chemical treatment is to swell the fibre prior to the mechanical refining. Depending upon the end use of pulp different approaches in the chemical pretreatment can be used.

The present study has been directed towards producing alkaline sulphite pulps from Eucalyptus tereticornis with good brightness and sufficient strength to be used in newsprint furnish.

2. OBJECT

The object of the present investigation was to evaluate the suitability of E. tereticornis for the production of alkaline sulphite pulp and to assess the suitability of these pulps for the manufacture of newsprint and other varieties of papers. The work was divided into two parts viz :

2.1 Part I

(i) To prepare alkaline sulphite pulps under different treatment conditions of sulphite - caustic.

(ii) To bleach the pulps by two stage hypochlorite and peroxide treatment.

(iii) To evaluate the properties of unbleached and bleached pulps.

2.2 Part II

(i) To study the influence of Na_2SO_3 in presence of higher NaOH concentration during chemical impregnation.

(ii) To study the properties of unbleached pulps prepared under the above conditions.

3. EXPERIMENTAL

3.1 Raw material :

Four billets of E. tereticornis were received from the Forest Department of Kerala Newsprint Project. The wood was received in air dry condition. There was no indication from which part of the tree the samples were collected. No data were available on tree age.

3.2 Chipping of the samples :

The billets were sawn into dimensions suitable for chipping in the pilot plant Waterous Disc Chipper. The chips were screened on the pilot plant Waterous Vibrating Screen. Chips passing through 44 mm square mesh and retained on a 6.5 mm square mesh were collected. The screened chips were stored in plastic bags. The moisture content of chips was 11.4 per cent.

3.3 Treatment of chips :

Chips were treated in 2.5 litre pressure vessels, rotating in an electrically heated oil bath. Sodium hydroxide and sodium sulphite of known concentrations and water were added to the chips to maintain a chip to liquor ratio of 1:3.5. The bomb was closed and a pressure of 8 kg/cm^2 was applied by nitrogen gas. The temperature of bomb was maintained at about 90°C. The treatment conditions are given in Table 1. After 60 min., the pressure was released. The bombs were removed from the bath and spent liquor was separated. pH and COD of spent liquor were determined. The treated chips were refined without washing with fresh water.

The refiner used in this work was a 12" Sprout Waldron Single Disc Refiner rotated at 2500 RPM by 40 KW motor. Plate pattern No. 178043 was used throughout the work. Refining was carried out with hot water at 50°C in the circulation system. The chips were refined in two passes - the first pass was carried out at 8.0% consistency at 0.625 mm clearance and the second pass was at 0.05 mm at 10.0% consistency.

The refined pulp was screened on a flat screen having 0.2 mm slot width with circulation of back water. Yield was determined by weighing the screened pulp.

3.4 Pulp evaluation :

Pulp fractionation was done with a Bauer-McNett classifier using 28,48,100 and 200 mesh screens as per SCAN-M6:69. The fibre classification results are given in Table 2.

Handsheets of 100 gsm were prepared on a British Sheet Making Machine with a closed back water system to reduce the losses of fines. Wet web strength properties were determined according to SCAN C31:77.

The handsheets were pressed under standard conditions and dried and conditioned at 27±1°C and 65±2% relative humidity.

The physical properties were tested according to ISO standard DP 5269. The evaluation data are presented in Table 3.

3.5 Bleaching :

All bleaching operations were carried out in plastic containers immersed in a thermostatically controlled water bath. Mixing was accomplished by periodic kneading during the treatment. After bleaching, pulps were washed with water. Prior to the final washing, sulphur dioxide (SO_2) water treatment was given to get the pH of the pulp around 4.5 to 5.0. Bleaching data are given in Tables 4 & 5.

The residual active bleaching chemical was determined by iodometric titration.

Final brightness, post colour number and yield on o.d. pulp were determined for all the bleached pulps. Optical properties of handsheets made from bleached pulps are presented in Tables 6 and 7.

4. RESULTS AND DISCUSSIONS

4.1 Part I

4.1.1 Unbleached pulp :

Alkaline sulphite liquor (Mixture of sodium hydroxide) and sodium sulphite) was not an effective chemical for sulphite pulping. Addition of more sulphite solution with NaOH (Pulps AS/Et/7, AS/Et/8 and AS/Et/9) reduced the yield. Yield varied between 77.3 to 82.8 per cent. In all the cases highest sulphite concentration gave pulps of the highest brightness.

The Bauer-McNett Classification shows that more than 30% of the pulp was obtained in the -200 mesh fraction. It is often observed in high yield pulping that dense woods produce a high percentage of fines during the refining operation.

Increasing the amount of sulphite in the treatment of chips gave better strength properties (Table 3). Wet web strength properties of these pulps are given in Table 8.

4.1.2 Bleached pulps :

Hypochlorite (two stage) and Hydrogen peroxide were used on the pulps prepared from different alkali and sulphite ratios. Pulp bleached with two stage hypochlorite has lower brightness than peroxide treated pulps. These pulps responded very well to these sequences. Pulps could be bleached to a brightness level of 51.6 to 56.0 with 9% available chlorine and 51.6 to 56.5 with 2% H_2O_2 respectively.

It is evident from results that when brightness is increased the opacity decreases. Scattering coefficient of these pulps was not changed to significant level as brightness increases.

4.2 Part II

The results obtained in Part I were used as a guide to the pulping. In part II consideration was given to the treatment of the chips in strong alkaline sulphite liquor. The work was extended to cover high NaOH concentration and low sulphite concentration. All other conditions covering treatment with the chemicals and refining were kept constant (details see in Table 9).

It is evident that pH after the treatment would remain more than 10.9. This shows that sufficient residual alkali is present in spent liquor after impregnation. Yields decreased on the increased dosage of NaOH concentration. Unbleached pulp brightness was 27.4 to 28.8%.

The influence of the different treatment conditions on strength properties of pulps are given in Table 10. These indicate clearly that stronger alkali and weaker sulphite improve the paper making properties of the pulp. Values interpolated at 200 CSF for these pulps are given in Table 11.

5. CONCLUSIONS

i/ The results discussed in Part I indicate that sulphite chemimechanical pulps of satisfactory strength properties cannot be produced from *E. tereticornis* for newsprint furnish.

ii/ Further studies on *E. tereticornis* (Part II) indicated that increasing the strength of NaOH used for treating the chips (15 to 25 gpl NaOH on wood) and weaker sulphite (7.5 to 12.5 gpl Na_2SO_3) gave pulps with improved strength properties. It appears that alkalinity of an alkaline sulphite liquor rather than the sulphite content is primarily responsible for pulp strength improvements.

iii/ The brightness of unbleached pulps from alkaline sulphite pulping is higher than those of cold soda pulps as expected.

REFERENCES

1. Giertz, H.W., International Mechanical Pulping Conference Helsinki, 1977 Proceeding, Vol. V 1977, 37-51.

2. Deb, U.K., Doctoral Thesis at NTH, Trondheim 1976.

3. Mantri, T.C. et. al. Research Progress Report No. 6, IND/73/012, New Delhi, India, December, 1978.

TABLE 1

CONDITIONS AND RESULTS OF ALKALINE SULPHITE PULPING

Sample numbers / Particulars	AS/Et/1	AS/Et/2	AS/Et/3	AS/Et/4	AS/Et/5	AS/Et/6	AS/Et/7	AS/Et/8	AS/Et/9
Chemical as NaOH applied, g/l	3.0	6.0	9.0	3.0	6.0	9.0	3.0	6.0	9.0
Chemical as Na_2SO_3 applied, g/l	4.5	9.0	13.5	6.0	12.0	18.0	9.0	18.0	27.0
Na_2SO_3/NaOH, w/w	1.5	1.5	1.5	2.0	2.0	2.0	3.0	3.0	3.0
pH of the impregnation liquor	12.7	12.7	12.4	12.8	12.9	12.8	12.9	12.8	12.8
pH of the spent liquor	8.7	9.5	10.3	8.8	9.7	10.3	9.1	9.8	10.2
Total yield, %	82.8	81.1	80.2	81.6	80.8	79.6	81.8	80.2	77.3
Rejects, %	0.7	1.9	1.8	4.5	1.9	7.1	5.2	0.7	5.0
Unbleached pulp brightness, %	31.0	33.8	34.5	31.7	33.1	34.7	31.6	34.0	34.8
COD of the spent liquor, g/l	13.49	17.89	18.91	10.32	19.18	25.77	11.51	18.06	26.05

Constant conditions

Chip quantity	= 450.0 g.o.d.
Chips to liquor ratio	= 1:3.5
Temperature, °C	= 90
Time, min.	= 60
N_2 Pressure, kg/cm^2	= 8.0

TABLE 2

BAUER - McNETT FIBRE CLASSIFICATION

Pulp Code numbers / Particulars	AS/Et/1	AS/Et/2	AS/Et/3	AS/Et/4	AS/ET/5	AS/Et/6	AS/Et/7	AS/Et/8	AS/Et/9
Mesh employed									
+28	21.9	23.7	26.7	25.8	27.1	24.9	27.9	25.9	21.8
+48	15.3	12.1	13.2	13.5	11.7	15.0	12.7	15.9	13.2
+100	1.2	5.9	4.0	2.1	1.6	1.9	1.2	22.9	29.9
+200	15.3	11.5	17.6	12.4	10.5	13.5	9.3	7.9	6.5
-200	46.3	46.8	38.5	46.2	49.1	44.7	48.9	27.4	28.6

TABLE 3

STRENGTH PROPERTIES OF ALKALINE SULPHITE UNBLEACHED PULPS

Sample numbers	PFI revolutions	Freeness CSF (ml)	Bulk cm^3/g	Density g/cm^3	Tensile index Nm/g	Stretch %	Tear index mNm^2/g	Air resistance Gurley s/100 ml
	Unbeaten	380	3.00	0.33	(1)	(1)	0.30	(1)
AS/Et/1	1000	260	2.78	0.36	(1)	(1)	0.35	(1)
	2000	150	2.78	0.36	(1)	(1)	0.35	(1)
AS/Et/2	Unbeaten	315	2.91	0.34	2.95	(1)	0.70	(1)
AS/Et/2	1000	160	2.78	0.36	3.60	0.8	0.75	1.2
	2000	115	2.65	0.38	3.90	0.9	0.70	1.6
	Unbeaten	495	2.94	0.34	4.0	0.9	1.00	(1)
AS/Et/3	1000	365	2.70	0.37	5.0	1.2	1.05	1.0
	2000	270	2.44	0.41	5.5	1.1	1.10	1.3
	4000	90	2.33	0.43	6.0	1.1	0.90	2.0
	Unbeaten	540	3.22	0.31	(1)	(1)	0.30	(1)
AS/Et/4	1000	410	3.12	0.32	(1)	(1)	0.30	(1)
	2000	300	2.78	0.36	(1)	(1)	0.35	(1)
	4000	180	2.13	0.47	(1)	(1)	0.30	(1)
	Unbeaten	465	3.33	0.30	(1)	(1)	0.65	(1)
AS/Et/5	1000	325	3.03	0.33	(1)	(1)	0.65	(1)
	2000	255	2.78	0.36	(1)	(1)	0.70	(1)
	4000	100	2.50	0.40	3.5	0.6	0.60	1.5
AS/Et/6	Unbeaten	660	3.03	0.33	3.5	0.5	0.80	(1)
AS/Et/6	2000	455	2.63	0.38	4.6	1.0	0.85	(1)
	4000	340	2.38	0.42	6.5	0.8	0.90	1.3
	8000	70	2.22	0.45	8.5	1.0	0.95	4.5
	Unbeaten	400	2.94	0.34	(1)	(1)	0.40	(1)
AS/Et/7	1000	270	2.78	0.36	(1)	(1)	0.60	1.0
	2000	105	2.70	0.37	(1)	(1)	0.45	1.2
	4000	90	2.56	0.39	(1)	(1)	0.45	1.8
	Unbeaten	515	2.95	0.34	(1)	(1)	0.70	(1)
AS/Et/8	2000	340	2.78	0.36	(1)	(1)	0.80	(1)
	4000	175	2.50	0.40	3.5	0.7	0.70	1.2
	6000	90	2.40	0.42	4.0	0.7	0.65	1.3
	Unbeaten	575	3.03	0.33	(1)	(1)	1.00	(1)
AS/Et/9	2000	405	2.78	0.36	5.5	(1)	1.00	1.0
	4000	185	2.44	0.41	7.0	1.1	1.00	1.6
	6000	75	2.33	0.43	8.0	1.1	1.05	2.5

(1) too low to be measured.

TABLE 4

TWO STAGE HYPOCHLORITE BLEACHING OF ALKALINE SULPHITE PULPS

Sample numbers	Hypo. app. as available Cl_2 %	Hypo consumed as available Cl_2 %	Buffer as NaOH %	Initial pH	Final pH	Brightness Elrepho %	Post colour number	Bleaching losses %	Bleached pulp yield on OD pulp basis %
AS/Et/1									
I	7.2	7.2	1.3	10.8	8.6	-	-	-	-
II	1.8	1.8	0.8	10.4	8.6	51.6	3.4	7.7	92.3
AS/Et/2									
I	7.2	7.2	1.3	10.5	9.2	-	-	-	-
II	1.8	1.8	0.7	10.1	8.7	52.4	4.2	6.9	93.1
AS/Et/3									
I	7.2	7.2	1.3	10.8	9.5	-	-	-	-
II	1.8	1.8	0.7	10.5	8.6	52.2	4.7	5.5	94.5
AS/Et/4									
I	7.2	7.2	1.3	10.7	9.2	-	-	-	-
II	1.8	1.8	0.7	10.1	8.5	54.5	3.6	5.1	94.9
AS/Et/5									
I	7.2	7.2	1.3	10.6	9.1	-	-	-	-
II	1.8	1.8	0.7	10.5	8.7	54.0	3.2	3.9	96.1
AS/Et/6									
I	7.2	7.2	1.3	10.9	8.8	-	-	-	-
II	1.8	1.8	0.7	10.2	8.5	54.3	2.3	3.3	96.7
AS/Et/7									
I	7.2	7.2	1.3	10.0	8.6	-	-	-	-
II	1.8	1.8	0.7	10.2	8.4	51.7	4.7	3.2	96.8
AS/Et/8									
I	7.2	7.2	1.3	10.9	8.5	-	-	-	-
II	1.8	1.8	0.7	10.5	8.4	56.0	4.1	3.4	96.6
AS/Et/9									
I	7.2	7.2	1.3	10.9	8.6	-	-	-	-
II	1.8	1.8	0.7	10.3	8.6	55.3	4.5	3.2	96.8

Note : I - I Stage Hypochlorite bleaching
II -II Stage Hypochlorite bleaching

Constant conditions

Consistency - 8.0% Temperature - 45±1°C
Time - 45 min. SO_2 was to decrease pH 5.0 to 5.5 after II stage bleaching

TABLE 5

HYDROGEN PEROXIDE BLEACHING OF ALKALINE SULPHITE PULPS

Sample numbers / Particulars	AS/Et/1	AS/Et/2	AS/Et/3	AS/Et/4	AS/Et/5	AS/Et/6	AS/Et/7	AS/Et/8	AS/Et/9
H_2O_2 applied on O.D. pulp, %	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
H_2O_2 consumed, %	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Sodium silicate applied, %	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
Magnesium sulphate applied, %	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
NaOH as buffer, %	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Initial pH	10.4	10.7	11.0	10.6	10.9	11.2	10.7	10.9	11.1
Final pH	10.1	10.0	10.2	10.1	10.3	10.2	10.2	10.3	10.2
Brightness Elrepho, %	53.5	54.2	54.2	52.2	55.5	56.5	48.1	54.5	56.0
Post colour number	2.1	1.4	1.6	1.1	1.4	1.3	3.5	2.9	1.9
Yield on O.D. pulp %	96.8	96.7	97.0	97.2	97.0	97.1	97.3	98.0	97.6
Bleaching losses	3.2	3.3	3.0	2.8	3.0	2.9	2.7	1.4	2.4

Constant conditions

Pulps were treated with 0.05% EDTA at 3.0% cy at room temperature before bleaching

Consistency = 10.0%, Temperature = 70±1°C, Time = 60 min. SO_2 wash to decrease pH to 5.0 - 5.5

TABLE 6

OPTICAL PROPERTIES OF TWO STAGE HYPOCHLORITE BLEACHED PULPS

Sample numbers / Particulars	AS/Et/1	AS/Et/2	AS/Et/3	AS/Et/4	AS/Et/5	AS/Et/6	AS/Et/7	AS/Et/8	AS/Et/9
Basis weight, g/m^2	80.2	63.0	68.5	79.6	64.3	71.0	68.6	74.0	70.2
Brightness, %	46.5	49.0	50.6	48.7	52.7	51.5	45.6	51.0	52.8
Opacity, %	96.8	92.1	92.5	93.6	91.6	91.3	94.1	92.5	91.5
Scattering coefficient, m^2/kg	37.0	37.0	36.8	37.1	39.2	35.3	34.7	34.6	37.4
Absorption coefficient, m^2/kg	4.4	3.4	2.7	3.1	2.7	2.4	4.1	2.5	2.3
Yellowness, %	32.7	32.8	33.7	32.3	31.6	33.8	34.3	31.7	32.7

Note : Unbleached pulps were prepared as per conditions given in Table 1.

TABLE 7

OPTICAL PROPERTIES OF PEROXIDE BLEACHED PULPS

Sample numbers / Particulars	AS/Et/1	AS/Et/2	AS/Et/3	AS/Et/4	AS/Et/5	AS/Et/6	AS/Et/7	AS/Et/8	AS/Et/9
Basis weight, g/cm^3	70.7	68.2	71.0	77.0	65.9	67.4	56.6	50.0	60.4
Brightness, %	48.1	50.9	52.7	48.7	54.2	54.7	43.7	50.6	53.5
Opacity, %	94.9	94.2	93.5	93.5	93.8	91.8	93.7	85.4	91.4
Scattering coefficient, m^2/kg	34.7	37.4	37.6	37.8	41.9	37.8	35.7	32.3	39.6
Absorption coefficient, m^2/kg	4.4	3.8	3.0	3.4	5.1	2.9	3.7	6.6	4.6
Yellowness, %	31.4	29.0	29.8	29.0	27.5	28.6	33.0	28.5	28.8

Note : Unbleached pulps were prepared as per conditions given in Table 1.

TABLE 8

WET WEB PROPERTIES OF ALKALINE SULPHITE PULPS AT 20±1% DRYNESS

Sample numbers	Freeness CSF ml	IWWT index Nm/g	TEA index mNm/g	% water retention value (WRV)
AS/Et/1	380	(1)	(1)	(1)
	260	(1)	(1)	(1)
	150	(1)	(1)	(1)
AS/Et/2	315	(1)	(1)	(1)
	160	(1)	(1)	(1)
	115	(1)	(1)	(1)
AS/Et/3	495	0.13	4.8	101
	365	0.13	3.6	103
	270	0.12	3.6	111
	90	0.09	2.4	117
AS/Et/4	540	(1)	(1)	(1)
	410	(1)	(1)	(1)
	300	(1)	(1)	(1)
	180	(1)	(1)	(1)
AS/Et/5	465	0.11	2.9	85
	325	0.11	2.2	89
	255	0.09	2.1	91
	100	0.07	1.4	94
AS/Et/6	660	0.08	2.7	100
	455	0.10	2.3	102
	340	0.08	2.1	104
	70	0.08	2.0	108
AS/Et/7	400	(1)	(1)	(1)
	270	(1)	(1)	(1)
	105	(1)	(1)	(1)
	90	(1)	(1)	(1)
AS/Et/8	515	0.09	3.8	86
	345	0.08	2.8	90
	175	0.08	2.5	94
	90	0.06	1.1	105
AS/Et/9	575	0.13	3.9	101
	405	0.15	3.9	109
	185	0.14	3.1	110
	75	0.07	1.9	112

(1) too low to be measured.

TABLE 9

CONDITIONS AND RESULTS OF ALKALINE SULPHITE PULPING

Sample numbers / Particulars		AS/Et/13	AS/Et/14	AS/Et/15
Chemical as NaOH applied,	g/l	15.0	20.0	25.0
Chemical as Na_2SO_3 applied,	g/l	7.5	10.0	12.5
Na_2SO_3/NaOH ratio	w/w	0.5	0.5	0.5
pH of the impregnation liquor		12.5	12.5	12.7
pH of the spent liquor		10.9	11.5	11.5
Total yield,	%	84.1	80.7	80.1
Rejects,	%	4.9	3.7	2.5
Unbleached pulp brightness,	%	27.5	27.4	28.8
COD released	g/l	42.76	47.72	48.82

Constant conditions

Chips to liquor ratio = 1:3.5

Temperature, °C = 90±1

Time, min. = 60

N_2 pressure = 8.0 kg/cm^2

TABLE 10

STRENGTH PROPERTIES OF ALKALINE SULPHITE PULPS

Sample numbers	Freeness CSF ml	Bulk cm^3/g	Density g/cm^3	Burst index $kPa.m^2/g$	Tensile index $N.m/g$	Stretch %	Tear index $mN.m^2/g$	Air resistance Gurley s/100 ml
	565	2.56	0.39	-	5.5	1.3	0.95	-
AS/Et/13	420	2.56	0.39	-	6.0	1.5	0.95	-
	315	1.36	0.42	-	7.5	1.5	1.00	1.5
	85	2.17	0.46	0.20	9.5	1.8	1.05	3.1
	485	2.63	0.38	-	6.0	1.2	1.10	1.0
AS/Et/14	315	2.27	0.44	-	8.0	1.7	1.30	1.2
	195	2.22	0.45	0.20	10.5	1.9	1.50	2.4
	60	1.89	0.53	0.30	13.5	2.0	1.40	6.7
	550	2.38	0.42	-	6.5	1.5	1.20	-
AS/Et/15	390	2.33	0.43	-	8.0	1.8	1.40	1.2
	280	2.17	0.46	0.20	8.5	2.0	1.40	2.0
	95	1.96	0.51	0.30	13.0	2.0	1.60	5.8

TABLE 11

STRENGTH PROPERTIES OF ALKALINE SULPHITE UNBLEACHED PULP AT 200 ml C.S.F.

Sample numbers	AS/Et/13	AS/Et/14	AS/Et/15
Particulars			
Burst index, $kPa.m^2/g$	-	0.20	0.24
Tensile index, Nm/g	8.3	10.50	10.50
Tear index, mNm^2/g	1.00	1.50	1.50
Initial wet web tensile index, Nm/g	0.14	0.14	0.17

TABLE 12

WET WEB STRENGTH OF ALKALINE SULPHITE PULPS AT 20±1% DRYNESS

Sample specifications	Freeness CSF ml	Initial wet web tensile index Nm/g	Tensile energy absorption index mNm/g
	565	0.12	2.9
AS/Et/13	420	0.12	3.3
	315	0.14	3.6
	85	0.15	3.4
	485	0.12	2.8
AS/Et/14	315	0.13	2.9
	195	0.13	3.3
	60	0.16	3.9
	550	0.15	2.4
AS/Et/15	390	0.15	4.1
	280	0.18	4.4
	95	0.18	4.9

ANNEXURE I

CONVERSION FACTORS FROM SI TO OBSOLESCENT (KGS) UNITS

ISO (International Organisation for Standardisation) methods were used in this investigation for pulp and paper testing. All results and calculations are expressed in SI units (Systeme International d'Unites) as this system was adopted in India.

Some basic SI units		Conversion to Obsolescent units
Mass	: Kg, g	
Length	: m	
Area	: m^2	
Time	: second (s)	
Force	: Newton (N) milliNewton (m^N)	1N = 0, 102 kp
Pressure	: Pascal (Pa) Kilopascal (kPa)	1Kpa = 0,0102 kp/cm^2
Dynamic viscosity Pa.s (Pascal second)		1P = 0,1 Pa.s 1cP= 10^{-3}Pa.s

Conversion of paper testing data :

From SI unit	To obsolescent unit	Multiply by
Tensile index N.m/g	Breaking length km	0,102
Burst index $kPa.m^2/g$	Burst factor	10,2
Tear index $mN.m^2/g$	Tear factor	10,2
Scattering coefficient m^2/kg	Scattering coefficient cm^2/g	10

For approximate indication tensile index can be converted to breaking length by dividing by 10, burst index converted to burst factor by multiplying by 10, tear index converted to tear factor by multiplying by 10.

It should be mentioned that in ISO standards the testing data are expressed on the basis of weight of conditioned sheet whereas other standards (e.g. APPITA) express results on basis of O.D. weight which makes exact conversion difficult.